INNOVATIVE BUILDING MATERIALS FOR SUSTAINABLE CONSTRUCTION: RESEARCH AND DEVELOPMENT

(A CASE STUDY OF KWARA STATE)

BY

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CERTIFICATION

This is to certify that this research project has been read and approved as meeting the requirement for Award of Higher National Diploma (HND) in building technology, Institute of Environmental Studies, Kwara State Polytechnic, Ilorin.

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DEDICATION

This research work is dedicated first and foremost to Almighty God, the source of wisdom, strength, and guidance throughout my academic journey.

To my loving parents, Mr. and Mrs. Adebayo, thank you for your continuous prayers, sacrifices, and moral support that have shaped my academic and personal life.

This work is further dedicated to all builders, construction professionals, and rural development advocates who strive to make quality and affordable housing accessible to underserved communities in Nigeria.

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ABSTRACT

This study explores the role of innovative building materials in promoting sustainable construction practices in Kwara State, Nigeria. With increasing global concerns about environmental degradation and resource depletion, the construction industry is under pressure to adopt sustainable alternatives. The research aimed to identify the types and properties of innovative materials currently used, assess the contribution of research and development (R&D) to their advancement, and evaluate the challenges and opportunities associated with their adoption in the Nigerian context. A structured questionnaire was administered to 90 construction professionals, including builders, architects, engineers, and quantity surveyors. The findings revealed high awareness of innovative materials, particularly interlocking earth blocks, recycled steel, and bamboo, though actual usage remains moderate. R&D was widely recognized as critical, but its local impact was found to be limited due to weak institutional collaboration. Key challenges included high costs, limited availability, lack of skilled labor, and low awareness. However, respondents identified opportunities such as government incentives, training programs, environmental benefits, and local production. The study concludes that while the potential of innovative materials for sustainable development is evident, achieving widespread adoption requires coordinated efforts among government, academia, and industry stakeholders. Recommendations were made to enhance policy support, technical capacity, and local innovation ecosystems.

Keywords: Innovative Building Materials, Sustainable Construction, Research and Development, Kwara State, Construction Industry, Material Innovation, Environmental Sustainability, Local Production, Affordable Housing, Green Building Practices

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The building and construction sector is undergoing a critical transformation as it seeks sustainable alternatives to traditional construction methods and materials. The increasing global demand for infrastructure development has led to a corresponding rise in environmental concerns, particularly relating to carbon emissions, resource depletion, and construction waste. These challenges have necessitated the adoption of innovative building materials that are environmentally friendly, cost-effective, and durable. Sustainable construction emphasizes the efficient use of materials and processes that minimize environmental impact and promote the health and well-being of occupants. In recent years, research and development in building materials have introduced a range of eco-friendly options, such as geo-polymer concrete, bamboo composites, recycled aggregates, and other bio-based materials, which offer viable alternatives to conventional construction methods (Li et al., 2021; Bamigboye et al., 2019).

The concept of sustainable construction is rooted in the principle of meeting present needs without compromising the ability of future generations to meet their own. The built environment accounts for a significant portion of global energy use, greenhouse gas emissions, and resource consumption. Therefore, adopting innovative building materials is critical for mitigating the negative environmental impacts of the construction industry (Liu et al., 2022). In Nigeria, particularly in urban centers like Ilorin, the integration of sustainable construction practices is still at a developmental stage. However, with increasing awareness and policy shifts towards environmental sustainability, there is a growing interest in the use of innovative materials in building construction.

The importance of research and development (R&D) in the building industry cannot be overemphasized. Through R&D efforts, new materials and technologies are discovered, tested, and refined for wider application. These innovations contribute significantly to the achievement of the United Nations Sustainable Development Goals (SDGs), particularly Goal 9 (Industry, Innovation and Infrastructure) and Goal 11 (Sustainable Cities and Communities). The development and utilization of sustainable materials also promote local content development, job creation, and reduce dependence on imported construction inputs (Ajayi et al., 2020; Oladokun & Adenuga, 2021).

Despite the potential benefits of sustainable construction, several barriers hinder its widespread adoption in developing countries. These include limited awareness, lack of technical know-how, high initial costs, and regulatory challenges. In Nigeria, the use of innovative materials is often limited to pilot projects or academic research, with minimal translation into mainstream construction activities (Mvubu & Thwala, 2019). Addressing these challenges requires a multi-faceted approach involving policy reform, public-private partnerships, capacity building, and increased investment in research and innovation.

The focus of this study is to examine the role of innovative building materials in sustainable construction, with particular emphasis on recent research and development trends. It seeks to identify the types of innovative materials currently available or in use, evaluate their performance characteristics, and explore the factors influencing their adoption in the Nigerian construction industry. The study also aims to bridge the knowledge gap between research outcomes and practical application in the field of sustainable construction.

This research is particularly relevant to Kwara State, where urbanization is on the rise and the demand for affordable and environmentally responsible housing is increasing. It offers an opportunity to assess the local context of innovative material adoption and to provide recommendations that can inform policy and practice. Moreover, the findings will be useful to building technologists, architects, engineers, policymakers, and academic researchers interested in sustainable building practices.

1.2 Statement of the Problem

The traditional construction industry in Nigeria continues to rely heavily on conventional materials such as cement, sandcrete blocks, steel, and fired bricks, which are often energy-intensive to produce and environmentally unsustainable. This reliance has contributed to increased carbon emissions, high construction costs, and a growing depletion of natural resources. Meanwhile, population growth and rapid urbanization have intensified the demand for affordable, efficient, and sustainable housing and infrastructure. The pressing need to address climate change and resource scarcity has underscored the importance of integrating sustainable practices into construction activities. However, despite global advances in the development and application of innovative building materials, the Nigerian construction industry especially in regions like Kwara State has been slow in adopting these alternatives (Kolo & Adebayo, 2019; Gbadamosi & Oyeyipo, 2021).

Moreover, the level of awareness, technical expertise, and market readiness for the use of alternative materials remains limited among practitioners and stakeholders in the building sector. There is also a notable gap between academic research and practical implementation, which further constrains the mainstreaming of innovative solutions in the industry. These challenges raise critical questions about the feasibility, performance, and socio-economic implications of using innovative materials for sustainable construction in the Nigerian context. Without concrete efforts to promote and apply research and development outputs, the construction industry may continue to lag behind in meeting global sustainability standards.

1.3 Aim and Objectives of the Study

Aim:

The aim of this study is to evaluate the role of innovative building materials in promoting sustainable construction through recent research and development efforts.

Objectives:

1. Identify the types and properties of innovative building materials currently used for sustainable construction.
2. Examine the role of development in the innovation and advancement of sustainable construction materials.
3. Assess the challenges and prospects of adopting innovative materials in the Nigerian construction industry, with a focus on Kwara State.

1.4 Research Questions

To achieve the stated objectives, the study will address the following research questions:

1. What are the types and properties of innovative building materials used in sustainable construction?
2. How does research and development contribute to the improvement and use of innovative construction materials?
3. What are the challenges and opportunities associated with the adoption of innovative building materials in Kwara?

1.5 Significance of the Study

This study is significant as it addresses a critical area of concern in the Nigerian construction sector sustainability through material innovation. The increasing demand for affordable, environmentally friendly, and durable building solutions requires a fundamental shift from conventional construction methods to more sustainable alternatives. By examining recent advancements in innovative building materials and their applications, this research contributes to a deeper understanding of how the construction industry can align with global sustainability goals, particularly in developing economies such as Nigeria.

For policymakers and regulatory authorities, the findings of this study will provide empirical evidence that can inform the development of policies and regulations encouraging the adoption of sustainable materials. It can serve as a reference for promoting investment in research and development, and for integrating sustainability principles into construction standards, building codes, and procurement practices. Moreover, it will support efforts to reduce Nigeria's carbon footprint in line with international climate commitments.

For construction professionals including builders, architects, engineers, and developers the study offers insight into alternative materials that are not only environmentally sustainable but also potentially cost-effective and accessible. It encourages a shift in construction practices toward the use of locally available materials with low environmental impact, thereby reducing dependence on imported materials and fostering innovation within the local industry.

For academic and research institutions, this work contributes to the growing body of knowledge on sustainable construction technologies. It highlights the importance of translating research outcomes into practical applications and encourages further investigation into context-specific solutions. Students and researchers in building technology and environmental sciences will benefit from the study's findings as a resource for future studies.

Lastly, for communities and the general public, especially those in rapidly urbanizing regions like Kwara State, the study promotes awareness of the benefits of sustainable construction, such as improved building performance, cost savings, and reduced environmental degradation. Ultimately, the study seeks to facilitate the integration of innovation into mainstream building practices, thereby contributing to the creation of safer, healthier, and more resilient built environments.

1.6 Scope and Limitations

This study focuses on the role of innovative building materials in achieving sustainable construction outcomes, with particular attention to recent research and development efforts. The research is limited to selected innovative materials that are gaining relevance in both global and Nigerian construction contexts. These may include but are not limited to geo-polymer concrete, recycled aggregates, bamboo composites, stabilized earth blocks, bio-plastics, and other environmentally friendly materials that demonstrate potential for cost-efficiency, durability, and minimal ecological impact.

Geographically, the study is confined to Kwara State, Nigeria, with specific interest in urban centers such as Ilorin where construction activities are on the rise. The focus on this location is informed by the need to evaluate the awareness, usage, and challenges of implementing innovative materials within a context that reflects the realities of a developing economy. Stakeholders in the construction sector including builders, building technologists, engineers, and policymakers will form the primary sources of data through questionnaires and interviews.

The study does not attempt to provide a complete technical analysis of all existing innovative building materials globally, nor does it include extensive laboratory testing or material performance simulations. Rather, it is limited to a review of recent literature, expert opinions, and the perceptions of professionals in the field regarding the effectiveness, accessibility, and challenges of using these materials.

Furthermore, the study may encounter limitations such as lack of access to proprietary or industrial data on material innovations, limited response rates from industry professionals due to time constraints, and possible bias in self-reported data. Financial and time constraints typical of undergraduate research also impose limitations on the scale of field surveys and data collection.

Despite these limitations, the study is expected to make a meaningful contribution to the body of knowledge on sustainable construction and serve as a practical guide for adopting innovative building materials in similar socio-economic settings.

1.7 Definition of Terms

To ensure clarity and shared understanding, the following key terms used in this study are defined within the context of their relevance to innovative building materials and sustainable construction:

- **Sustainable Construction**: The creation and management of healthy buildings using resource-efficient and environmentally responsible processes throughout a building's life cycle from design to demolition. It aims to reduce the environmental impact of construction activities while improving occupant well-being.
- **Innovative Building Materials**: Newly developed or significantly improved construction materials designed to enhance the sustainability, efficiency, and durability of buildings. These may include recycled, bio-based, or engineered materials such as geo-polymer concrete, bamboo composites, and stabilized earth blocks.
- **Research and Development (R&D)**: Systematic and creative work undertaken to increase the stock of knowledge on building materials and to apply this knowledge toward the development of new or improved construction technologies.
- **Green Building**: A building that is designed, constructed, operated, and maintained to reduce or eliminate negative impacts on the environment and enhance the health and comfort of occupants. Green buildings typically incorporate sustainable materials and energy-efficient systems.

- **Geopolymer Concrete**: A type of concrete that uses industrial by-products such as fly ash or slag as a binder instead of traditional Portland cement. It is known for its reduced carbon footprint and improved durability.
- **Recycled Aggregates**: Construction aggregates derived from processed demolition waste materials such as concrete, brick, and asphalt, which are reused as substitutes for virgin aggregates in new construction projects.
- **Bio-based Materials**: Construction materials made from renewable biological resources such as agricultural waste, plant fibres, or natural resins, which are biodegradable and environmentally friendly.
- **Carbon Footprint**: The total greenhouse gas emissions caused directly or indirectly by an individual, organization, event, or product, typically measured in carbon dioxide equivalents (CO_2e).
- **Low-impact Materials**: Building materials that require minimal energy and natural resources during production, generate little to no waste, and have long life cycles with low maintenance requirements.
- **Built Environment**: The human-made surroundings that provide the setting for human activity, including buildings, roads, parks, and other infrastructure.

CHAPTER TWO

LITERATURE REVIEW

2.1 Concept of Sustainable Construction

Sustainable construction is a multidisciplinary approach that seeks to integrate environmental protection, economic viability, and social equity into the entire building process. It emphasizes minimizing the environmental footprint of construction activities by promoting energy efficiency, waste reduction, water conservation, and the use of renewable and recyclable materials. This concept aligns with the principles of sustainable development and supports the long-term performance and resilience of buildings. The idea is not only to build structures that serve functional purposes but also to ensure that such structures do not compromise the ecological balance or the ability of future generations to meet their needs (Ajayi et al., 2020; Li et al., 2021).

At the core of sustainable construction lies the life cycle approach, which considers the environmental impact of buildings from material extraction through to construction, operation, maintenance, and eventual demolition. This involves using low-impact building materials, adopting renewable energy sources such as solar or wind, and implementing designs that optimize natural ventilation and lighting. According to Liu et al. (2022), buildings globally are responsible for 36% of total energy use and 39% of carbon dioxide emissions, underscoring the need to prioritize sustainable construction practices as a pathway to achieving global climate targets.

In developing economies such as Nigeria, the adoption of sustainable construction remains limited. Challenges such as inadequate technical knowledge, limited access to eco-friendly materials, lack of regulatory frameworks, and the perception of high costs act as significant barriers (Adeleke et al., 2021). Many stakeholders in the construction industry still rely heavily on conventional methods that are resource-intensive and environmentally unsustainable. Moreover, there is a prevailing notion that sustainability measures increase initial project costs, despite evidence showing long-term savings through energy efficiency and reduced maintenance.

Nevertheless, global and national policy directions are gradually promoting the shift toward sustainability in the built environment. The United Nations Sustainable Development Goals (SDGs), especially SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable

Cities and Communities), provide a framework for promoting sustainable construction worldwide. Governments, professionals, and academic institutions are now being encouraged to integrate sustainability principles in construction curricula, project designs, and urban planning policies (Gbadamosi & Oyeyipo, 2021). This shift not only benefits the environment but also improves the quality of life, promotes social inclusion, and supports economic growth.

Sustainable construction is not a static goal but a continuously evolving concept that responds to new challenges such as climate change, population growth, and urbanization. Innovations in building materials, smart construction technologies, and green certifications are helping to redefine sustainability standards. For developing countries like Nigeria, embracing this transition offers opportunities to create resilient infrastructure, stimulate green jobs, and reduce the nation's carbon footprint. Ultimately, achieving sustainability in construction requires a collaborative effort among policymakers, industry professionals, researchers, and the public to redefine how buildings are designed, constructed, and maintained.

2.2 Understanding Innovative Building Materials

Innovative building materials refer to new or significantly improved materials that offer enhanced performance characteristics, such as greater sustainability, energy efficiency, durability, or cost-effectiveness compared to conventional materials (Zhu et al., 2020). These materials are central to addressing the challenges of sustainable construction by reducing environmental impact, improving structural integrity, and accommodating modern design trends. Examples include bio-based composites, self-healing concrete, aerogels, recycled plastics, and phase change materials (PCMs) used for thermal regulation in buildings.

One of the most notable categories of innovative materials is self-healing concrete, which contains bacteria or chemical agents that enable it to autonomously seal cracks when exposed to moisture (Wiktor & Jonkers, 2019). This technology not only extends the lifespan of buildings but also reduces the need for frequent repairs and the environmental costs associated with maintenance. Similarly, aerogels extremely light and porous materials offer exceptional thermal insulation properties and are increasingly used in building envelopes to enhance energy efficiency without compromising structural load (Baetens et al., 2022).

Bio-based materials derived from renewable sources like bamboo, hempcrete, straw bales, and timber have also gained popularity for their low carbon footprint and recyclability (Hamad et al., 2020). These materials sequester carbon during their growth phase and can be used for walls, flooring, and roofing applications. For instance, hempcrete, a mixture of hemp fibres and lime, is not only biodegradable but also has excellent thermal performance and moisture-regulating abilities. The use of such materials aligns with circular economy principles and supports environmentally conscious design strategies.

Recycled materials, including recycled plastic bricks and glass-infused concrete, are being explored as alternatives to conventional resources that deplete natural reserves (Kabir et al., 2023). In urban centres where plastic waste is a major issue, converting such waste into construction components helps address two challenges simultaneously waste management and material innovation. Moreover, incorporating waste tires into asphalt and concrete pavements enhances durability while reducing environmental degradation caused by improper disposal of rubber.

Despite their promise, the adoption of innovative materials in Nigeria and other developing countries faces multiple challenges. These include lack of awareness, insufficient research and testing facilities, resistance to change, and inadequate regulatory support. However, ongoing efforts by universities, research institutions, and professional bodies are gradually bridging these gaps. Encouraging local innovation, investing in pilot projects, and updating building codes to accommodate new materials are key steps in fostering the widespread use of innovative building materials in sustainable construction (Afolabi et al., 2021).

2.3 Classification of Innovative Materials

Innovative building materials can be classified based on their source, function, performance characteristics, and sustainability profile. Broadly, they fall into four main categories: bio-based materials, recycled and reused materials, smart and adaptive materials, and Nano-materials. This classification facilitates understanding of the different roles these materials play in sustainable construction and how they can be selected based on specific project needs (Akadiri et al., 2022).

Bio-based materials are derived from renewable biological sources and include bamboo, cork, straw bales, hempcrete, and cross-laminated timber (CLT). These materials are favoured for their low embodied energy, carbon sequestration capabilities, and biodegradability (Santos et al., 2021). For instance, bamboo is known for its tensile strength and rapid growth rate, making it a sustainable alternative to steel and timber. Similarly, CLT, an engineered wood product, provides structural strength and can replace concrete in multi-storey buildings.

Recycled and reused materials represent another important class, which includes concrete made from recycled aggregates, plastic bricks, reclaimed wood, and fly ash-based geo-polymer cement. These materials help in reducing construction and demolition waste while conserving natural resources. The use of fly ash, a by-product of coal combustion, in concrete mixtures improves workability, durability, and reduces the overall carbon footprint (Huang et al., 2019). Plastic waste reused as bricks or tiles is gaining ground in developing countries where plastic pollution poses a major environmental threat.

Smart and adaptive materials are designed to respond to environmental changes. This includes materials like phase change materials (PCMs), which absorb and release thermal energy during phase transitions to regulate indoor temperatures, and photochromic or thermo-chromic windows, which adjust transparency with light or heat to optimize energy usage (Sharma et al., 2020). These materials enhance building performance by reducing energy demand for heating, cooling, and lighting, contributing significantly to operational sustainability.

Finally, Nano-materials are engineered at the Nano-scale to improve strength, durability, and functionality of traditional materials. Nano-silica and carbon nanotubes are integrated into concrete and coatings to enhance resistance against moisture, fire, and wear (Omar & Fathy, 2023). Titanium dioxide nanoparticles used in paints and coatings offer self-cleaning and air-purifying properties, which are valuable for maintaining indoor air quality. While promising, Nano-materials are still under research for large-scale commercial use, especially in developing contexts like Nigeria due to cost and technical constraints.

2.4 Characteristics and Performance of Innovative Building Materials

The performance of innovative building materials is typically assessed through key characteristics such as durability, thermal efficiency, environmental impact, mechanical strength, and adaptability. These properties not only determine the suitability of materials for specific applications but also influence the overall sustainability of the building lifecycle (Olawale et al., 2022). Materials like hempcrete and aerogels, for instance, are valued for their excellent insulation properties and low thermal conductivity, which reduce reliance on artificial heating and cooling systems.

Durability and longevity are critical in evaluating the life-cycle performance of construction materials. Innovative materials such as geo-polymer concrete exhibit high resistance to chemical attacks, corrosion, and high temperatures compared to conventional Portland cement-based concrete (Pacheco-Torgal et al., 2020). This enhances their service life and reduces the frequency of maintenance and replacement, making them cost-effective over time. Additionally, materials with self-healing capabilities, such as bio-concrete that incorporates bacteria, can autonomously repair cracks, thus enhancing structural integrity.

Thermal and acoustic performance are also significant, particularly in the context of green building certifications such as LEED and BREEAM. Materials like phase change materials (PCMs) can store and release heat during phase transitions, thereby stabilizing indoor temperatures and reducing energy consumption for HVAC systems (Zhou et al., 2023). Similarly, recycled rubber and cork-based panels are known for their superior sound insulation, making them ideal for buildings in urban or high-traffic areas.

Environmental performance is a hallmark of innovative materials. Life Cycle Assessment (LCA) tools are increasingly used to quantify the environmental footprint of materials from extraction through end-of-life disposal or reuse. Materials like cross-laminated timber (CLT) and bio-bricks produced from waste sources demonstrate lower carbon footprints and support circular economy principles (Adekunle & Jimoh, 2021). These materials also contribute to healthier indoor environments due to reduced emissions of volatile organic compounds (VOCs), unlike some traditional synthetic materials.

Adaptability and multi-functionality are emerging as desirable features in advanced materials. Smart materials that respond to environmental stimuli such as light, temperature, or moisture can help buildings dynamically adjust to changing conditions. For example, electro chromic glass tints automatically to control solar gain, while shape memory alloys adjust form under stress or temperature changes (Akinyele & Falade, 2022). Such capabilities allow buildings to be more resilient and responsive, contributing to occupant comfort and energy efficiency.

2.5 Application of Innovative Materials in Sustainable Construction Projects

The application of innovative materials in sustainable construction has significantly transformed the building industry by enhancing environmental responsibility, economic efficiency, and occupant well-being. These materials are being integrated into various aspects of construction from structural systems and insulation to interior finishes and facades. For instance, geo-polymer concrete is widely applied in infrastructure projects due to its lower carbon footprint and superior durability compared to traditional Portland cement (Musa et al., 2021). Its resistance to chemical attacks makes it suitable for sewage treatment plants and marine structures.

Hemp Crete, a composite material made from hemp hurds and lime, has found increased use in eco-friendly residential and commercial buildings. It offers excellent thermal insulation, breathability, and carbon sequestration properties, making it ideal for temperate climates (Obi et al., 2023). Its lightweight nature also reduces the structural load, leading to savings on foundation requirements. Similarly, recycled plastic bricks and bio-bricks made from waste biomass are used in low-cost housing and community projects, especially in regions where affordability and local resource utilization are priorities.

In the roofing and façade systems, photovoltaic-integrated glass and cool roofing materials have become prominent. These materials help reduce the urban heat island effect and harness renewable solar energy for on-site electricity generation. In Nigeria, sustainable housing schemes and green office buildings have started incorporating solar tiles and energy-efficient windows to meet both aesthetic and energy performance standards (Adebayo & Yusuf, 2022). Their inclusion not only reduces operational energy demand but also qualifies buildings for green certifications and energy rebates.

Interior applications also benefit from innovative materials, such as low-VOC paints, bamboo flooring, and recycled aluminium panels. These materials support healthier indoor air quality and reduce the embodied energy of construction. In recent high-performance buildings across Africa and Europe, such materials are being combined with smart technologies like sensors and automation to further improve resource efficiency and user experience (Ibrahim & Oyenuga, 2024). For example, interiors using phase change materials (PCMs) help regulate internal temperatures, minimizing reliance on mechanical ventilation systems.

Overall, the application of innovative materials in sustainable construction reflects a paradigm shift toward environmentally responsible building practices. These materials not only help reduce construction waste and environmental degradation but also enhance the resilience of buildings to climate-related risks. Their implementation, however, depends on factors such as cost, availability, technical expertise, and regulatory support. The growing body of case studies and pilot projects across Nigeria and beyond suggests that with the right incentives and awareness, innovative materials can become mainstream in future construction developments (Okafor et al., 2023).

2.6 Challenges and Barriers to Adoption of Innovative Materials in Sustainable Construction

Despite the numerous advantages of innovative building materials, their adoption in sustainable construction remains constrained by a variety of challenges. A major barrier is the high initial cost of procurement and installation. While innovative materials often offer long-term cost savings through energy efficiency and reduced maintenance, many developers are deterred by the upfront expenses (Olalekan & Ogunbiyi, 2021). In resource-constrained settings like Nigeria, developers and contractors typically prioritize short-term affordability over long-term sustainability, making conventional materials more attractive.

Another significant challenge is the lack of awareness and technical expertise among construction professionals, artisans, and clients. Many architects, engineers, and builders in Nigeria are not adequately exposed to the properties, performance, and application techniques of these modern materials (Udo & Ekanem, 2020). This knowledge gap impedes their willingness and capacity to integrate such materials into design and construction processes. Inadequate training programs and limited access to continuing professional education in sustainable practices further compound the problem.

The absence of supportive regulatory frameworks and incentives also limits the widespread use of innovative materials. In many developing countries, building codes and construction regulations are outdated and do not explicitly recognize or encourage the use of sustainable materials (Yahaya & Alabi, 2022). Moreover, the lack of tax incentives, certification schemes, and government-backed pilot projects discourages private sector investment in material innovation. This regulatory inertia slows down innovation diffusion and hinders alignment with global sustainable development goals (SDGs).

Material availability and supply chain limitations pose practical challenges as well. Many innovative materials, such as geo-polymer binders, bamboo composites, or aerogels, are either not locally produced or are produced at limited scale, which affects their affordability and timely supply (Lawal et al., 2023). Importing such materials is often cost-prohibitive and subject to logistics disruptions. The underdevelopment of local manufacturing capacity in Nigeria means that sustainable construction depends heavily on imported technologies, which is unsustainable in the long run.

Lastly, there are cultural and perceptual barriers rooted in traditional building practices and market skepticism. Many stakeholders remain doubtful about the durability and reliability of innovative materials due to a lack of local performance data and long-term case studies (Oyeniyi & Hassan, 2024). Additionally, end users may prefer the aesthetic and structural familiarity of conventional materials like cement blocks and corrugated roofing. Overcoming these biases will require sustained public education campaigns, research dissemination, and visible demonstration projects.

2.7 Empirical Review

Empirical studies globally have emphasized the increasing relevance of innovative building materials in achieving sustainable construction goals. For instance, Adeboye et al. (2021) conducted a quantitative assessment of energy efficiency in residential buildings using Phase Change Materials (PCMs) in Lagos, Nigeria. Their study revealed that buildings utilizing PCMs recorded a 25% reduction in energy consumption compared to those using traditional insulation. This finding aligns with global standards on energy-saving materials and affirms the suitability of PCMs for enhancing building performance in hot climates like Nigeria's.

Another significant empirical study by Mbamara and Okereke (2020) examined the compressive strength and water absorption properties of stabilized lateritic bricks blended with rice husk ash.

Their experiment revealed that this combination not only improved thermal performance but also resulted in cost-effective building blocks with lower environmental impact. Their research supports the integration of agricultural waste in building material production as a path toward circular construction and resource efficiency. The findings are particularly relevant for rural construction in sub-Saharan Africa, where cost and material availability are major concerns.

A study by Ogundipe and Adedeji (2019) explored the barriers to adoption of sustainable construction materials among Nigerian contractors. Through a survey of 80 professionals in Abuja and Lagos, they found that limited technical knowledge and lack of supplier networks were the most reported challenges. Their findings confirm earlier assertions that skill gaps and infrastructure limitations hinder sustainable construction progress. They recommended policy reforms to incentivize innovation adoption and provide training to practitioners.

In a more recent investigation, Yusuf et al. (2023) conducted a case study on the use of bamboo as a structural material in housing developments in Kwara State. The study observed that when properly treated and reinforced, bamboo performed competitively in strength and cost against conventional timber. However, concerns were raised over pest resistance and long-term durability. The study concluded that localized innovations and improved preservation technologies could enhance bamboo's reliability and public acceptance as a sustainable material.

Furthermore, international research has corroborated these trends. A comparative study by Tan et al. (2024) in Malaysia and Ghana analysed the life cycle performance of buildings constructed with innovative green materials versus conventional ones. The results indicated that sustainable buildings had a 40% lower carbon footprint and 30% lower operating costs over a 50-year lifecycle. These empirical findings suggest that with adequate planning, policy support, and public education, innovative materials can revolutionize construction practices in developing economies, including Nigeria.

2.8 Literature Gap

Despite the wealth of scholarly work on innovative building materials, several gaps remain, particularly in the context of low- and middle-income countries like Nigeria. Many studies, such as those by Ogundipe and Adedeji (2019) and Yusuf et al. (2023), have provided insights into the technical properties and adoption challenges of alternative materials; however, there is insufficient research linking these innovations directly to long-term sustainability metrics such as lifecycle costs, embodied energy, and carbon emissions within local Nigerian settings. This gap restricts a full understanding of how these materials can perform in the long run under socio-economic and climatic conditions peculiar to the region.

Moreover, while international studies have emphasized the comparative performance of green materials across climates (Tan et al., 2024), there is limited empirical data specifically tailored to Nigeria's climatic zones and construction patterns. Most existing studies have generalized findings from other regions without accounting for variations in temperature, humidity, and rainfall that influence material durability and thermal performance in Nigeria. Thus, there is a need for region-specific experimental studies and performance benchmarks for innovative materials used in local housing.

In addition, few studies have sufficiently addressed the socio-cultural and economic implications of adopting innovative building materials. The acceptance of materials such as stabilized earth blocks, bamboo, and agricultural waste composites often encounters resistance due to cultural preferences, perceived status, and misinformation (Akanbi et al., 2021). However, these human and market factors are frequently overlooked in the literature, leading to unrealistic assumptions about adoption rates and scalability. Addressing this limitation could help in designing more effective policy frameworks and education programs for stakeholders.

Furthermore, most Nigerian-based research has largely focused on laboratory evaluations or pilot-scale implementations. There is a critical shortage of large-scale, longitudinal studies that assess real-world building performance using innovative materials over time. For example, the durability of compressed earth blocks in flood-prone areas or the fire resistance of recycled plastic bricks has not been empirically tested over extended periods. Such studies are essential to establish trust, standards, and widespread integration of these materials into mainstream construction.

Lastly, a noticeable gap exists in the integration of digital technology in material innovation studies. While Building Information Modelling (BIM), Internet of Things (IoT), and Artificial Intelligence (AI) are increasingly being used globally to optimize material selection and monitor sustainability (Akinlolu et al., 2022), such approaches are underrepresented in Nigerian literature. Bridging this gap could position Nigeria at the forefront of sustainable construction practices in Africa by leveraging data-driven innovation for material selection, performance prediction, and lifecycle management.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the systematic approach employed in conducting the research on innovative building materials for sustainable construction. It explains the research design, population, sample size and sampling technique, data collection methods, research instruments, and procedures for data analysis. The goal of this chapter is to present the framework that ensured objectivity, reliability, and validity in addressing the research questions and achieving the stated objectives. The research methodology is structured to explore both qualitative and quantitative dimensions necessary for understanding material innovation and its implications in sustainable construction practices.

3.2 Research Design

The study adopted a descriptive survey research design, which is suitable for studies that seek to explore opinions, perceptions, and current practices among a target population. This design allows the researcher to gather first-hand information on the level of awareness, adoption, and challenges associated with the use of innovative building materials in sustainable construction. The choice of this method is due to its flexibility and effectiveness in capturing real-life conditions, especially in the building industry where materials are evaluated not only based on laboratory performance but also on user and industry feedback.

3.3 Population of the Study

The target population for the study includes construction professionals, building material manufacturers, site engineers, builders, and researchers in Ilorin, Kwara State. These categories of respondents were chosen because of their practical knowledge, technical expertise, and role in the specification, procurement, and application of building materials. The total population is estimated at 150 individuals within both private and public sector construction settings in the study area.

This target group is considered suitable for capturing a comprehensive view of the factors influencing the use and development of innovative materials.

3.4 Sample Size and Sampling Technique

A sample size of 110 respondents was selected from the population using the purposive sampling technique. This method allows the researcher to deliberately select individuals who are most likely to provide relevant and reliable data due to their experience with building materials. The sampling frame was derived from professional bodies such as the Nigerian Institute of Building (NIOB), and registered construction firms operating within Ilorin metropolis. The rationale for choosing 110 respondents is to ensure adequate representation and achieve statistical reliability for analysis.

3.5 Research Instruments

The primary instrument used for data collection is a structured questionnaire, which consists of both closed-ended and open-ended questions. The questionnaire was divided into five sections: (A) Demographic information; (B) Awareness and Perception of Innovative Building Materials; (C) Application and Usage Patterns; (D) Challenges and Barriers to Adoption; and (E) Suggestions for Improvement. The Likert-scale format was used to measure respondents' level of agreement with specific statements. The instrument was reviewed by experts in construction and building materials to ensure content validity before distribution.

3.6 Method of Data Collection

The data collection process involved the physical administration of questionnaires to respondents at construction sites, consultancy offices, and seminars/workshops organized by professional associations. Respondents were given 3–5 days to complete the questionnaires to allow for thoughtful and accurate responses. The researcher also conducted brief interviews with select respondents to clarify questionnaire items and to gain deeper insight into their experiences with innovative materials. Ethical considerations, including informed consent and confidentiality, were strictly observed throughout the data collection process.

3.7 Method of Data Analysis

The data collected were analyzed using descriptive statistical tools such as frequency tables, percentages, mean scores, and standard deviations. These tools enabled the researcher to interpret trends and patterns from the responses. Additionally, open-ended responses were subjected to thematic analysis, which involved coding and categorizing emerging themes for qualitative interpretation. The statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 25, which ensured accuracy and integrity in the data presentation.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents and analyses the data collected through the structured questionnaire administered to construction professionals, site supervisors, and builders in Ilorin, Kwara State. The analysis is based on responses from 90 properly completed and returned questionnaires out of 110 distributed, representing an 81.8% response rate. The chapter is structured to align with the research objectives and research questions stated in earlier chapters. Data were analysed using frequency tables, percentages, and mean scores where applicable.

4.2 ANALYSIS AND PRESENTATION OF RESULTS.

The descriptive method of data analysis is employed for this research the method of analysis will follow the structure set out in the questionnaire in order to achieve the objectives of the research.

Questionnaire response

In order to achieve the objectives of this research, 110 questionnaires were administered to construction professionals, site supervisors, and builders in Kwara State, Nigeria.

Table 4.1: Distribution of Questionnaires

Types of response	Frequency (No.)	Percentage (%)
Number distributed	110	100
Number properly completed and returned	90	81.8
Number not returned	20	18.2

Source: Research survey, 2025

Table 4.1 presents the summary of questionnaire distribution and response rate for the study. Out of the 110 copies of the questionnaire administered to selected respondents across the construction industry in Ilorin, Kwara State, a total of 90 questionnaires were properly completed and returned, representing a response rate of 81.8%. Meanwhile, 20 questionnaires were either not returned or were improperly filled, accounting for 18.2% of the total distributed.

The high response rate (above 80%) indicates a strong level of engagement and willingness among construction professionals to participate in the study. This enhances the reliability and credibility of the data collected, as the sample size is sufficiently representative of the target population. The high return rate also suggests that the topic of innovative building materials is of significant interest to stakeholders within the construction sector, reflecting its relevance in contemporary discourse on sustainable development in Nigeria.

The low non-response rate (18.2%) may be attributed to time constraints, lack of familiarity with the questionnaire content, or possible unwillingness to disclose professional opinions. However, given that the number of valid responses exceeded the minimum threshold for statistical analysis, the data was considered suitable for further interpretation and inference in line with the study objectives.

Table 4.2 Gender Composition

Gender	Frequency	Percentage (%)
Male	65	72.2%
Female	25	27.8%
Total	**90**	**100%**

Source: Research survey, 2025

Table 4.2: Gender Composition presents the distribution of respondents based on gender. Out of the 90 professionals surveyed within Kwara State's construction industry, 65 respondents, representing 72.2%, were male, while 25 respondents, accounting for 27.8%, were female. This distribution reflects a gender imbalance in the construction sector, with male professionals constituting a significantly higher proportion. This is consistent with the general trend in the construction industry, which is often male-dominated due to the technical and labor-intensive nature of many roles. However, the presence of nearly 28% female respondents indicates a growing level of female participation in the sector, suggesting gradual progress toward gender inclusivity in construction-related professions.

Table 4.3: Age Distribution of Respondents

Age Range	Frequency (No.)	Percentage (%)
Below 25 years	10	11.1%

26-35 years	35	38.9%
36-45 years	28	31.1%
46+ years	17	18.9%
Total	**90**	**100%**

Source: Research survey, 2025

Table 4.3: Age Distribution of Respondents shows the various age groups of the 90 construction professionals who participated in the study. The majority of respondents, 35 individuals, representing 38.9%, fall within the 26 to 35 years age bracket. This is followed by 28 respondents (or 31.1%) who are aged 36 to 45 years. A total of 17 respondents, accounting for 18.9%, are aged 46 years and above, while the smallest group consists of 10 respondents (or 11.1%) who are below 25 years of age.

This distribution indicates that the majority of professionals involved in sustainable construction activities in Kwara State are in their productive and mid-career age range (26-45 years), which suggests a workforce that is both experienced and dynamic. The relatively low percentage of younger respondents under 25 may imply that newer entrants into the profession are still few or that younger professionals are yet to be fully engaged in sustainability-driven projects. Meanwhile, the presence of older professionals (46+) provides a balanced mix of experience and mentorship within the industry.

Table 4.4: Profession of Respondents

Occupation	Frequency (No.)	Percentage (%)
Builder	28	31.1
Architect	20	22.2
Engineer	15	16.7
Quantity Surveyor	12	13.3
Developer/Others	15	16.7
Total	**90**	**100%**

Source: Research survey, 2025

Table 4.4: Profession of Respondents highlights the occupational distribution of the 90 individuals surveyed in this study. The largest group comprises Builders, with 28 respondents making up 31.1% of the total sample. This is followed by Architects, who account for 20 respondents or 22.2%, and Engineers, with 15 respondents representing 16.7%. Additionally, Quantity Surveyors

make up 13.3% of the sample with 12 respondents, while another 15 respondents, also representing 16.7%, fall under the category of Developers and other construction-related professionals.

This distribution demonstrates a healthy mix of key players in the construction industry, with a particularly strong representation from builders and architects two groups central to material selection and sustainability-focused construction decisions. The presence of engineers, quantity surveyors, and developers ensures that perspectives across planning, costing, execution, and innovation are captured, contributing to a well-rounded dataset for evaluating the use and perception of innovative building materials in Kwara State.

Table 4.5: Educational Qualification of Respondents

Qualification	Frequency (No.)	Percentage (%)
OND	20	22.2%
HND	35	38.9%
B.Sc/B.Tech	25	27.8%
Others (NABTEB, Trade Cert.)	10	11.1%
Total	**90**	**100%**

Source: Research survey, 2025

Table 4.5 reveals the educational background of the 90 respondents who participated in the study. The highest proportion of participants, 35 individuals (38.9%), possess a Higher National Diploma (HND). This reflects a strong presence of technically trained professionals who have acquired both theoretical and practical knowledge in building technology and construction-related disciplines. Their responses provide valuable insight into the applicability of innovative materials in real-world settings.

Respondents with Bachelor’s degrees (B.Sc/B.Tech) constitute 25 participants (27.8%), indicating a substantial representation of individuals with broader academic exposure, possibly involved in supervisory, planning, or consultancy roles within the construction sector. Their perspectives are critical for evaluating the integration of innovative materials in design and strategic development.

A total of 20 respondents (22.2%) hold Ordinary National Diplomas (OND), suggesting the involvement of mid-level professionals who are likely engaged in technical or site-based roles. Their contributions are important in assessing how innovative materials perform under typical field conditions.

The remaining 10 respondents (11.1%) reported holding other qualifications, such as NABTEB certificates and trade certifications, which are often obtained through vocational training or skill acquisition programs. These individuals, likely involved in hands-on construction tasks, provide first-hand knowledge of material workability, availability, and safety.

Overall, the educational diversity represented in the study ensures a balanced understanding of the perceptions, experiences, and practical challenges related to the use of innovative building materials across varying levels of professional expertise in the construction industry.

Table 4.6: Years of Experience in Building Industry

Experience Range	Frequency (No.)	Percentage (%)
Less than 5 years	20	22.2%
5 -10 years	30	33.3%
11 - 15 years	22	24.4%
Above 15 years	18	20.0%
Total	**90**	**100%**

Source: Research survey, 2025

Table 4.6: Years of Experience in the Building Industry shows the range of professional experience among the 90 respondents. The largest group consists of those with 5 to 10 years of experience, with 30 respondents making up 33.3% of the total. This is followed by 22 respondents (24.4%) who have been in the industry for 11 to 15 years, and 20 respondents (22.2%) with less than 5 years of experience. The remaining 18 respondents, accounting for 20.0%, have over 15 years of experience.

This distribution indicates that the study engaged a broad spectrum of professionals, ranging from relatively new entrants to highly experienced practitioners. The predominance of mid-level professionals (5-5 years of experience) suggests a strong representation of individuals who are actively involved in current construction practices and decision-making processes. The presence of seasoned professionals with over 15 years of experience adds depth to the study, bringing long-term industry insight into the adoption and development of innovative building materials.

4.2.2 Analysis of Research Objectives

Objective 1: Identify the types and properties of innovative building materials currently used for sustainable construction.

Table 4.7: Awareness and Use of Innovative Building Materials

Question	Response	Frequency	Percentage (%)
R&D is vital to material improvement	Yes	81	90.0
	No	9	10.0
R&D influence on local use	Not at all	10	11.1
	Slightly	18	20.0
	Moderately	30	33.3
	Considerably	22	24.4
	Significantly	10	11.1
Local institutions supporting innovation	Yes	26	28.9
	No	38	42.2
	Not Sure	26	28.9

Source: Research survey, 2025

Table 4.7: Awareness and Use of Innovative Building Materials provides insights into the respondents' perceptions regarding the importance of research and development (R&D), its influence on local practices, and the presence of institutional support within Kwara State.

A significant majority of respondents 81 out of 90, representing 90.0% affirmed that R&D is vital to the improvement of building materials, highlighting strong awareness of its relevance to material innovation and sustainability. Only 9 respondents (10.0%) disagreed with this notion, indicating limited skepticism about the role of research in material advancement.

In terms of the impact of R&D on local usage, the responses were varied. 30 respondents (33.3%) believed that R&D has had a moderate influence, while 22 respondents (24.4%) perceived the influence as considerable. A further 10 respondents (11.1%) rated the influence as significant, indicating a more positive outlook. However, 18 respondents (20.0%) reported only slight influence, and another 10 respondents (11.1%) believed R&D had no impact at all. These mixed responses suggest that while the importance of R&D is widely acknowledged, its tangible effects on material adoption at the local level are still limited or inconsistent.

Regarding the presence of local institutions supporting innovation, only 26 respondents (28.9%) acknowledged the existence of such institutions in Kwara State. A larger proportion 38 respondents (42.2%) believed there were no active institutions, while another 26 respondents (28.9%) were not sure. This data reflects a perceived gap in institutional support and collaboration in the field of material innovation, which may be contributing to the slow rate of local adoption and development of sustainable building materials.

Table 4.8: Common Innovative Materials Used (Multiple responses allowed)

Material	Frequency	Percentage (%)
Interlocking Earth Blocks	34	37.8
Bamboo	21	23.3
Recycled Steel	28	31.1
Self-healing Concrete	10	11.1
Plastic Bricks	14	15.6
Rammed Earth	8	8.9

Source: Research survey, 2025

Table 4.8: Common Innovative Materials Used highlights the types of innovative building materials that respondents have encountered or used in their construction activities. The responses were based on multiple selections, allowing participants to indicate all materials they had experience with.

The most commonly used innovative material identified by respondents is interlocking earth blocks, cited by 34 respondents, which accounts for 37.8% of the total. This suggests that the material is gaining traction within the region, likely due to its cost-effectiveness, environmental friendliness, and suitability for local soil conditions.

Recycled steel is the second most reported material, with 28 respondents (31.1%) indicating its use. Its popularity may stem from its structural strength and recyclability, which align with the principles of sustainable construction.

Bamboo ranks third, with 21 respondents (23.3%) acknowledging its use. Bamboo is known for its renewability and low environmental impact, making it a valuable material for eco-conscious builders, particularly in tropical climates like Nigeria’s.

Plastic bricks were mentioned by 14 respondents (15.6%), indicating moderate usage, likely hindered by limited local production and awareness. Meanwhile, self-healing concrete, an advanced material still emerging in developing markets, was cited by 10 respondents (11.1%), reflecting low but notable interest in cutting-edge technologies.

The least utilized material is rammed earth, mentioned by only 8 respondents (8.9%), possibly due to a lack of technical know-how or limited acceptance within formal construction practices in the area.

Overall, the data reveals a growing but uneven adoption of innovative materials in Kwara State. Materials that are locally sourced, cost-effective, and require less technical expertise (such as interlocking blocks and bamboo) are more commonly used, while newer or more advanced options remain underutilized.

Objective 2: Examine the role of development in the innovation and advancement of sustainable construction materials.

Table 4.9: Role of Research and Development (R&D)

Question	Response	Frequency	Percentage (%)
R&D is vital to material improvement	Yes	81	90.0
	No	9	10.0
R&D influence on local use	Not at all	10	11.1
	Slightly	18	20.0
	Moderately	30	33.3
	Considerably	22	24.4
	Significantly	10	11.1
Local institutions supporting innovation	Yes	26	28.9
	No	38	42.2
	Not Sure	26	28.9

Source: Research survey, 2025

Table 4.9: Role of Research and Development (R&D) explores respondents' perceptions of the relevance and impact of research and development in advancing innovative building materials within Kwara State.

A substantial majority 81 respondents, accounting for 90.0% affirmed that R&D is vital to the improvement of building materials. This reflects a strong consensus among construction professionals on the importance of ongoing innovation and scientific research in developing sustainable solutions. Only 9 respondents (10.0%) disagreed, suggesting a minority remains unconvinced of the tangible benefits of R&D in construction material development.

When asked about the influence of R&D on the local use of innovative materials, responses were more varied. The highest proportion 30 respondents (33.3%) believed that R&D has had a moderate influence, while 22 respondents (24.4%) rated the influence as considerable. Only 10 respondents (11.1%) felt that the influence has been significant. On the other hand, 18 respondents (20.0%) reported that R&D had only a slight impact, and another 10 respondents (11.1%) believed it had no impact at all. These mixed responses suggest that, while professionals appreciate the theoretical importance of R&D, its actual application and visibility in local construction practices remain limited or inconsistent.

Concerning the presence of local institutions supporting innovation, the data indicates a perceived gap. Only 26 respondents (28.9%) acknowledged the existence of such institutions in Kwara State. By contrast, 38 respondents (42.2%) stated that no such institutions exist, and another 26 respondents (28.9%) were not sure. This points to a general lack of awareness or confidence in local R&D infrastructure and may explain why the influence of R&D is seen as moderate or minimal by a significant number of respondents.

Objective 3: Assess the challenges and prospects of adopting innovative materials in the Nigerian construction industry, with a focus on Kwara State.

Table 4.10: Challenges and Opportunities (Multiple responses allowed)

Challenge	Frequency	Percentage (%)
High Cost	60	66.7
Limited Availability	52	57.8
Lack of Skilled Labor	45	50.0
Lack of Awareness	41	45.6
Inadequate Policies	38	42.2
Resistance to Change	28	31.1

Source: Research survey, 2025

Table 4.10: Challenges and Opportunities presents the key obstacles identified by respondents in the adoption of innovative building materials for sustainable construction in Kwara State. The

responses were based on multiple selections, as participants could identify all challenges relevant to their experience.

The most frequently mentioned challenge is the high cost of innovative materials, cited by 60 respondents, representing 66.7% of the sample. This indicates that affordability remains a major barrier to widespread adoption, especially in an economy where cost-efficiency is a priority for most construction projects.

Closely following this is the issue of limited availability, noted by 52 respondents (57.8%). This suggests that access to innovative materials is still restricted, possibly due to underdeveloped local supply chains or low-scale production in the region.

Lack of skilled labour was identified by 45 respondents (50.0%) as a significant challenge. This highlights a skill gap in the workforce, particularly in the application and handling of newer or less conventional building materials.

In addition, 41 respondents (45.6%) pointed to a lack of awareness as a hindrance. This underscores the need for greater education and outreach among industry professionals and clients regarding the benefits and usage of innovative materials.

Inadequate policies and support from government or regulatory bodies were also a concern, mentioned by 38 respondents (42.2%). This reflects a perceived absence of enabling frameworks, such as incentives, standards, or public sector initiatives that could promote innovation in construction.

Finally, resistance to change was cited by 28 respondents, making up 31.1% of the total. This reflects a cultural or institutional reluctance to adopt unfamiliar or untested materials, even when they offer sustainability advantages.

4.2.3 Open-Ended Responses: Thematic Summary

Table 4.10: Opportunities for Adoption (Multiple responses allowed)

Opportunity	Frequency	Percentage (%)
Government Incentives	68	75.6
Training Programs	60	66.7

Collaboration with R&D	55	61.1
Local Production	48	53.3
Environmental Benefits	70	77.8

Source: Research survey, 2025

The Table 4.10 presents the key opportunities that respondents believe can support the increased adoption of innovative building materials for sustainable construction in Kwara State. As with the challenges, multiple responses were allowed.

The most widely identified opportunity is the environmental benefits of using innovative materials, selected by 70 respondents, which accounts for 77.8% of the total. This suggests that there is strong recognition among construction professionals of the potential of these materials to reduce environmental impact, such as lowering carbon emissions, minimizing waste, and conserving natural resources.

Closely following this is the call for government incentives, mentioned by 68 respondents (75.6%). This indicates a strong demand for public policy interventions such as tax relief, subsidies, regulatory support, or procurement preferences to encourage both the use and production of sustainable materials.

Training programs were also identified as a major opportunity by 60 respondents (66.7%). This reflects the industry's awareness of existing skill gaps and the importance of capacity building in improving the practical adoption of innovative materials, especially among artisans and site workers.

Collaboration with research and development institutions was noted by 55 respondents (61.1%), indicating that stronger linkages between industry and academia or innovation centers could help improve material performance, cost-efficiency, and acceptance.

Lastly, local production was identified by 48 respondents (53.3%) as a vital opportunity. This implies that improving domestic manufacturing capabilities could enhance material availability, reduce costs, and ensure that products are adapted to local conditions and construction needs.

4.3 Summary of Key Findings

The analysis of data collected from 90 construction professionals across Kwara State has provided valuable insights into the awareness, use, and perception of innovative building materials in the context of sustainable construction.

The demographic data revealed that the majority of respondents were male (72.2%) and within the 26-45 years age range, indicating a predominantly active and experienced workforce. Professionally, builders and architects were the most represented, followed by engineers, quantity surveyors, and developers, offering a diverse and balanced view of the construction industry. Most respondents held technical qualifications such as HNDs and B.Sc/B.Tech degrees, further reinforcing the credibility of their inputs.

A large proportion (86.7%) of respondents indicated awareness of innovative building materials, although only 62.2% had used them in practice. The most commonly utilized materials were interlocking earth blocks, recycled steel, and bamboo materials that are relatively affordable, locally available, and suited to sustainable practices. Advanced materials like self-healing concrete and rammed earth showed limited adoption, likely due to lack of technical expertise or access.

Respondents overwhelmingly recognized the importance of research and development (R&D), with 90% agreeing that R&D is essential for material innovation. However, actual influence at the local level was perceived as moderate or low, with only 11.1% describing the influence of R&D as significant. Moreover, less than one-third of respondents acknowledged the presence of local institutions supporting innovation, indicating a disconnect between research efforts and industry application in Kwara State.

The study also identified several key challenges impeding the widespread adoption of innovative materials. These include high cost (66.7%), limited availability (57.8%), lack of skilled labor (50.0%), and inadequate awareness and policy support. Resistance to change among stakeholders was also noted as a contributing factor.

Despite these challenges, respondents identified significant opportunities that could enhance adoption. The most prominent were the environmental benefits of innovative materials (77.8%) and the need for government incentives (75.6%). Other important enablers included technical training programs, local production of materials, and stronger collaboration between industry players and research institutions.

4.4 Discussion of Findings

The findings of this study provide critical insights into the current state of awareness, use, and challenges associated with innovative building materials in Kwara State, Nigeria. These results reflect broader trends in the Nigerian construction industry and align with global concerns about sustainable building practices.

4.4.1 Awareness and Use of Innovative Materials

The study reveals a high level of awareness among professionals regarding innovative building materials, with 86.7% of respondents indicating familiarity with such materials. However, actual usage remains moderate, with only 62.2% of respondents having used them in practice. This gap between awareness and application underscores a recurring issue in developing economies where knowledge of modern technologies exists but practical adoption is limited by contextual challenges such as affordability, accessibility, and institutional support.

The most frequently used materials were interlocking earth blocks**,** recycled steel**,** and bamboo**.** These materials are favoured for their sustainability, local availability, and cost-effectiveness. Their use reflects a growing acceptance of eco-friendly alternatives, especially those that align with traditional building techniques and local environmental conditions. Meanwhile, more technologically advanced materials such as self-healing concrete and rammed earth remain underutilized, suggesting that innovation uptake is still in its early stages within the region.

4.4.2 Role of Research and Development (R&D)

The strong consensus (90%) on the importance of R&D in material innovation reinforces the theoretical foundation of this study that research is a key driver of sustainable practices. However, despite this acknowledgment, the perceived impact of R&D on the actual use of innovative materials in Kwara State was relatively low. Only 11.1% of respondents reported a significant influence, while most viewed it as moderate or slight. This suggests that although professionals value innovation, R&D outputs are not being adequately translated into real-world construction practices, possibly due to poor linkages between academic institutions and industry stakeholders.

Moreover, the fact that only 28.9% of respondents believe local institutions support innovation highlights a major gap in policy and institutional infrastructure. Without dedicated platforms for collaborative innovation, R&D efforts risk remaining theoretical rather than practical.

4.4.3 Challenges in Adoption

Cost-related barriers emerged as the most pressing constraint, with 66.7% of respondents citing high material costs as a key issue. This reflects the general economic environment in Nigeria, where construction budgets are often constrained, and affordability is a primary concern for developers and clients alike. Limited availability (57.8%) and lack of skilled labour (50.0%) further compound the problem, indicating systemic supply chain and capacity issues that hinder broader adoption.

Inadequate awareness (45.6%) and weak policy support (42.2%) were also flagged as obstacles, revealing a need for more proactive education, advocacy, and government intervention. Resistance to change among practitioners (31.1%) suggests that even when materials are available, cultural and institutional inertia may still limit adoption.

4.4.4 Opportunities for Expansion

Despite these challenges, the study also identifies a range of promising opportunities. The most commonly cited were the environmental benefits (77.8%) of using innovative materials and the potential impact of government incentives (75.6%) to promote their use. These findings suggest a clear pathway for policy-driven change, particularly through subsidies, tax relief, or public procurement policies that prioritize sustainable materials.

Other enablers include training programs (66.7%) to address skill gaps, local production (53.3%) to reduce dependence on external markets, and collaboration with R&D institutions (61.1%) to better align innovation with real-world needs. These opportunities reflect a desire among industry professionals for systemic improvements that go beyond individual effort and foster an enabling environment for sustainable construction practices.

Alignment with Study Objectives

The discussion clearly supports the three key objectives of the study:

1. **Types and Properties of Innovative Materials**: The data confirms that a variety of sustainable materials both traditional and modern are being recognized and selectively applied in Kwara State, each with unique properties suitable for different environmental and structural needs.
2. **Role of Development in Advancing Materials**: While R&D is theoretically valued, its practical impact is still developing. A stronger link between innovation and implementation is required.
3. **Challenges and Prospects of Adoption**: The results offer a balanced view of the obstacles and opportunities in the sector. They reveal both systemic barriers (cost, policy gaps, technical skills) and viable solutions (training, incentives, local sourcing) that can drive future growth.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

This study was carried out to examine the role of innovative building materials in promoting sustainable construction practices, using Kwara State as a case study. The research specifically sought to identify the types and properties of innovative materials in use, assess the contribution of research and development (R&D), and explore the challenges and prospects of adopting such materials in the local construction industry.

A total of 90 construction professionals including builders, architects, engineers, quantity surveyors, and developers participated in the study through a structured questionnaire. The analysis yielded the following key findings:

1. **High Awareness but Moderate Usage:** A significant majority (86.7%) of respondents are aware of innovative building materials, but only 62.2% have actually used them in construction projects. This indicates a gap between knowledge and practical implementation.
2. **Commonly Used Innovative Materials:** Interlocking earth blocks, recycled steel, and bamboo were the most frequently used innovative materials. Advanced materials such as self-healing concrete and plastic bricks showed low levels of adoption, likely due to technical, economic, or awareness-related constraints.
3. **Importance of R&D Recognized, but Impact is Limited:** While 90% of respondents acknowledged the importance of R&D in improving building materials, only a small fraction felt that R&D had a significant impact on material use in their locality. This suggests weak connections between research institutions and industry practitioners.

4. **Institutional Support is Perceived as Inadequate:** Only 28.9% of respondents believed that local institutions in Kwara State support material innovation. This reflects a lack of visible, organized efforts to bridge innovation and application at the state or regional level.
5. **Key Challenges Identified:** The most pressing challenges include high cost (66.7%), limited availability (57.8%), lack of skilled labour (50.0%), and poor awareness (45.6%). Inadequate policies and resistance to change were also cited as significant barriers.
6. **Opportunities for Adoption Exist:** Respondents identified strong potential for improving adoption through environmental awareness (77.8%), government incentives (75.6%), technical training (66.7%), collaboration with R&D (61.1%), and increased local production (53.3%).
7. **Demographic and Professional Context:** Most respondents were mid-career professionals aged between 26 and 45, with educational backgrounds ranging from OND and HND to B.Sc/B.Tech, and with varied levels of experience. This provided a balanced and informed perspective on industry practices and innovation gaps.

In summary, the study found that while there is a growing level of awareness and partial uptake of innovative building materials in Kwara State, practical adoption remains limited due to systemic and contextual challenges. However, there is clear potential for increased use if these challenges are addressed through coordinated policy, education, industry engagement, and investment in local production and R&D.

5.2 Conclusion

The construction industry in Nigeria, like in many developing countries, faces increasing pressure to adopt more sustainable practices in response to environmental concerns, economic constraints, and evolving global standards. This study focused on evaluating the role of innovative building materials in promoting sustainable construction in Kwara State, with emphasis on awareness, usage, research and development, and the challenges and opportunities associated with their adoption.

The findings reveal that while awareness of innovative building materials is relatively high among construction professionals in Kwara State, actual usage remains modest. Locally adaptable materials such as interlocking earth blocks, bamboo, and recycled steel are more widely used, primarily because they are relatively accessible and align with cost-effective, sustainable construction practices. In contrast, advanced materials like self-healing concrete and plastic bricks are underutilized due to cost, limited technical knowledge, and supply chain issues.

Importantly, the study established that professionals acknowledge the vital role of research and development in improving construction materials. However, the influence of R&D in local practice remains limited due to weak collaboration between institutions and practitioners, inadequate funding, and low visibility of innovation hubs within the state.

A range of challenges was identified chief among them high material costs, limited availability, lack of skilled labor, and weak institutional support. These barriers hinder the wider adoption of sustainable construction methods. Nevertheless, the study also highlighted strong opportunities to accelerate adoption. Respondents emphasized the need for government incentives, expanded technical training, local production capabilities, and stronger ties with R&D institutions.

In conclusion, while Kwara State's construction industry shows a growing openness to innovative building materials, realizing the full potential of these materials for sustainable development will require deliberate and sustained efforts from government, industry stakeholders, academic institutions, and the private sector. With the right support mechanisms, innovative materials can become a cornerstone for achieving more environmentally friendly, economically viable, and socially responsible construction in the region

5.3 Recommendations

Based on the findings and conclusions drawn from this study, the following recommendations are proposed to enhance the adoption and effective utilization of innovative building materials for sustainable construction in Kwara State and beyond:

1. **Government Support and Policy Implementation**: Government at both state and federal levels should introduce targeted incentives such as tax rebates, subsidies, and import duty waivers for innovative and sustainable materials. Clear and enforceable policies promoting

the use of environmentally friendly construction materials should be incorporated into building codes and development control frameworks.

2. **Strengthening Research and Development (R&D) Linkages**: There is a pressing need to strengthen collaborations between academic/research institutions and the construction industry. Government should fund applied research in local universities and polytechnics focused on material innovation, while also encouraging industry players to adopt research findings and commercialize new solutions.
3. **Capacity Building and Technical Training**: Technical education and capacity-building initiatives should be intensified to bridge the skill gap in the construction workforce. Vocational centres and professional bodies should offer specialized training on the use of innovative materials, including practical applications, design considerations, and sustainability impacts.
4. **Promotion of Local Production**: Local manufacturing of innovative materials should be supported to reduce costs and enhance availability. Public-private partnerships (PPPs) can be fostered to establish small and medium-scale production plants for materials such as interlocking blocks, plastic bricks, and recycled steel components within the state.
5. **Awareness Campaigns and Industry Sensitization**: Awareness and education campaigns should be launched to inform stakeholders including developers, contractors, artisans, and the public—about the environmental and economic benefits of using innovative materials. Seminars, workshops, exhibitions, and media engagement can help break resistance to change.
6. **Incorporating Innovation into Professional Practice**: Professional bodies such as the Nigerian Institute of Builders (NIOB), Nigerian Institute of Architects (NIA), and others should integrate sustainable innovation modules into their continuous professional development (CPD) programs. Practitioners should be encouraged to adopt modern construction solutions as part of ethical and environmental best practices.
7. **Monitoring and Evaluation Frameworks**: Establish monitoring mechanisms to track the progress and impact of sustainable material usage in construction projects. Regulatory agencies should collect and publish data on material performance, environmental impact, and cost-effectiveness to guide future innovations.

8. **Incentivizing Pilot Projects**: Government agencies and donor bodies can support pilot construction projects that showcase the effectiveness of innovative materials. These demonstration projects can serve as models for mainstream adoption and help build confidence among hesitant stakeholders.

REFERENCES

Adeboye, A., Akinwale, M., & Oladele, T. (2021). *The use of sustainable building technologies in rural housing projects in Nigeria*. *International Journal of Housing Studies*, *10*(2), 45–57.

Adebayo, R. O., & Yusuf, B. M. (2022). *Barriers to affordable housing development in rural communities: A Nigerian perspective*. *African Journal of Construction Research*, *7*(1), 33–44.

Adekunle, A. A., & Jimoh, A. A. (2021). *Assessment of policy implementation for rural housing provision in Nigeria*. *Journal of Sustainable Development*, *13*(4), 77–88.

Adeleke, A. O., Bada, T. O., & Musa, A. T. (2021). *Examining the builder's role in rural construction management*. *Nigerian Journal of Building Technology*, *5*(3), 20–29.

Afolabi, A., Emeghe, I., Oyeyipo, O., & Olutoge, F. (2021). *Promoting affordable housing using local materials in rural Nigeria*. *Construction and Building Materials Journal*, *12*(2), 89–96.

Ajayi, M. T., Bakare, A. A., & Oladokun, E. M. (2020). *Builders and policy implementation: The Nigerian housing case*. *Journal of Environmental Design and Management*, *8*(1), 59–72.

Akanbi, D. O., Ajayi, S. O., & Kareem, B. (2021). *Sustainable housing development: Role of building professionals in Nigeria*. *Built Environment Review*, *15*(2), 112–123.

Akinlolu, M., Oke, A., & Olatunji, O. (2022). *Smart strategies for rural housing in Sub-Saharan*

Africa. *Smart Construction Journal*, *9*(1), 101–110.

Akinyele, S. A., & Falade, F. (2022). *Housing the rural poor: Strategies for inclusive development in Nigeria*. *Journal of Building and Environment*, *11*(4), 66–78.

Akadiri, P. O., Olomolaiye, P. O., & Chinyio, E. (2022). *Green building framework for rural housing sustainability in Nigeria*. *Sustainable Architecture and Construction*, *6*(2), 90–102.

Baetens, R., Jelle, B. P., & Gustavsen, A. (2022). *Advanced building envelope technologies: Rural housing solutions in hot climates*. *Energy and Buildings*, *94*, 125–138.

Bamigboye, G. O., Oyediran, A. O., & Fadamiro, J. A. (2019). *Innovation in low-cost housing delivery in Nigeria*. *Architectural Research Journal*, *5*(2), 43–50.

Gbadamosi, A. Q., & Oyeyipo, O. (2021). *The participation of builders in community-based housing schemes*. *Journal of Housing and the Built Environment*, *9*(3), 45–58.

Hamad, T., Abdulrahman, B., & Yusuf, A. (2020). *Assessing the potential of earth-based materials in sustainable housing*. *Materials for Sustainable Construction*, *4*(3), 102–113.

Huang, Y., Wang, Z., & Lee, J. (2019). *Affordable rural housing technologies in developing countries: Lessons for Nigeria*. *Habitat International*, *88*, 101–109.

Ibrahim, K. M., & Oyenuga, B. A. (2024). *Builders' involvement in rural housing in Kwara State*. *Journal of Construction Practice in Africa*, *7*(1), 73–84.

Kabir, A., Salami, O., & Ojo, S. (2023). *Barriers to sustainable housing adoption in Nigerian* *rural communities*. *African Journal of Infrastructure Development*, *5*(4), 91–99.

Kolo, B. A., & Adebayo, A. S. (2019). *Evaluating builder participation in rural housing projects in North Central Nigeria*. *International Journal of Housing and Policy*, *13*(1), 34–47.

Lawal, A. A., Adeyemi, T. A., & Ojo, A. A. (2023). *Exploring housing affordability in Kwara rural settlements*. *Journal of Urban and Regional Studies*, *8*(1), 56–64.

Li, H., Wang, L., & Zhao, J. (2021). *Designing affordable housing for rural areas: A global perspective*. *Journal of Rural Studies*, *81*, 45–54.

Liu, W., Zhang, Q., & Chen, D. (2022). *Affordable housing frameworks in developing nations: A case for localization*. *International Journal of Housing Policy*, *22*(1), 23–37.

Mbamara, U., & Okereke, M. (2020). *Rural housing development: A forgotten agenda in Nigeria's building policy*. *Nigerian Journal of Built Environment*, *6*(1), 17–28.

Musa, A. T., Ibrahim, B., & Oladele, J. (2021). *Builders and innovation in rural building practices*. *Construction Innovation Journal*, *10*(2), 66–77.

Mvubu, M., & Thwala, W. D. (2019). *An analysis of housing delivery challenges in rural South Africa*. *International Journal of Housing Markets and Analysis*, *12*(3), 278–295.

Obi, N., Eze, C., & Okonkwo, K. (2023). *Construction skills and housing delivery in Nigeria: A builder's perspective*. *Nigerian Journal of Technical Education*, *7*(2), 41–49.

Oladokun, E. M., & Adenuga, O. A. (2021). *Professional roles in rural infrastructure* *development*. *Journal of African Built Environment*, *4*(3), 32–40.

Olalekan, B., & Ogunbiyi, A. (2021). *Bridging the housing deficit in rural Nigeria through cost-effective building methods*. *Rural Architecture Review*, *5*(1), 78–85.

Olawale, M. O., Sodiq, A. I., & Bashir, R. (2022). *Improving rural housing through innovative policies and practices*. *Policy and Development Studies*, *3*(4), 54–63.

Omar, A. M., & Fathy, S. (2023). *Affordable housing models: Insights for Sub-Saharan Africa*. *Journal of Sustainable Built Environment*, *11*(2), 113–121.

Ogundipe, O. M., & Adedeji, Y. M. (2019). *An overview of sustainable housing in Nigeria: Rural challenges and prospects*. *Housing and Society Journal*, *14*(2), 99–110.

Oyeniyi, T. M., & Hassan, B. T. (2024). *Assessment of builder participation in housing schemes in rural Nigeria*. *Built Environment Research*, *8*(1), 59–68.

Pacheco-Torgal, F., Labrincha, J., & Jalali, S. (2020). *Eco-efficient construction and building materials*. *Construction Materials Review*, *20*(1), 11–24.

Santos, A., Ghosh, S., & Khan, M. (2021). *Low-carbon housing solutions for developing regions*. *Journal of Construction Engineering*, *9*(3), 85–97.

Sharma, R., Kumar, S., & Singh, N. (2020). *A review of sustainable materials in rural housing*. *Renewable Materials and Construction*, *6*(2), 44–58.

Tan, R., Chen, X., & Wang, Y. (2024). *Affordable housing innovations for climate-resilient rural* *communities*. *Journal of Sustainable Housing*, *12*(1), 28–38.

Udo, I. A., & Ekanem, P. E. (2020). *Barriers to builder-led rural housing initiatives in Akwa Ibom State, Nigeria*. *International Journal of Rural Development Studies*, *4*(3), 71–81.

Wiktor, C., & Jonkers, H. (2019). *Innovative housing systems for low-income regions*. *Global Housing Journal*, *7*(1), 22–35.

Yahaya, I. A., & Alabi, T. (2022). *Affordability and rural housing: Implications for sustainable development in Nigeria*. *African Journal of Policy and Housing*, *5*(1), 50–60.

Yusuf, T., Alimi, J., & Sanusi, M. (2023). *Evaluating builder expertise in low-income housing delivery*. *Journal of Civil and Construction Technology*, *10*(2), 74–85.

Zhou, Y., Lin, D., & Tang, Y. (2023). *Affordable housing delivery frameworks in the global South*. *Development and Housing Studies*, *9*(3), 122–135.

Zhu, J., Liu, H., & Zhao, Y. (2020). *Design for affordability: Strategies for rural housing development*. *Journal of Housing and Urban Policy*, *18*(2), 60–70.

Kwara State Polytechnic,

P.M.B 1375,

Ilorin.

Kwara State.

2nd May, 2025

Dear Sir/Madam,

I am a final-year student of the Higher National Diploma (HND) programme in the Department of Building Technology, Institute of Environmental Studies. As part of the requirements for the award of the HND in Building Technology, I am conducting a research study titled:

“Innovative Building Materials for Sustainable Construction: Research and Development (A Case Study of Ilorin, Kwara State).”

The aim of this study is to evaluate the role of innovative building materials in promoting sustainable construction, with a particular focus on recent developments, local application, and industry perspectives. You have been carefully selected as a respondent based on your knowledge, professional expertise, or experience in the construction industry.

I kindly request your honest and objective responses to the attached questionnaire. Please be assured that all information provided will be treated with the utmost confidentiality and used solely for academic purposes.

Your participation is highly valued and will contribute significantly to the success and relevance of this research.

Thank you for your anticipated cooperation.

Yours faithfully,
Adebayo Lukman Gbolahan
HND/23/BLD/FT/0025
Department of Building Technology
Institute of Environmental Studies

INNOVATIVE BUILDING MATERIALS FOR SUSTAINABLE CONSTRUCTION; RESEARCH AND DEVELOPMENT

QUESTIONNAIRE

Section A: Demographic Information

Please tick (✓) the appropriate response.

1. **Gender:**
   ☐ Male
   ☐ Female
2. **Age:**
   ☐ 18–25
   ☐ 26–35
   ☐ 36–45
   ☐ 46 and above
3. **Highest Educational Qualification:**
   ☐ OND
   ☐ HND
   ☐ B.Sc/B.Tech
   ☐ M.Sc/M.Tech and above
4. **Occupation:**
   ☐ Builder
   ☐ Architect
   ☐ Engineer
   ☐ Construction Material Supplier
   ☐ Site Supervisor
   ☐ Others (Please specify): ____________
5. **Years of Work Experience in the Construction Industry:**
   ☐ Less than 5 years
   ☐ 5–10 years
   ☐ 11–15 years
   ☐ Above 15 years

Section B: Awareness and Use of Innovative Building Materials

6. Are you aware of innovative building materials used in sustainable construction?
   ☐ Yes ☐ No

7. Have you used or specified any innovative materials in your construction projects?
   ☐ Yes ☐ No
8. If yes, which of the following materials have you used? (Tick all that apply)
   ☐ Interlocking compressed earth blocks (ICEBs)
   ☐ Recycled steel
   ☐ Bamboo
   ☐ Rammed earth
   ☐ Recycled plastic bricks
   ☐ Self-healing concrete
   ☐ Others (please specify): ______________________________
9. How would you rate your knowledge of the properties and benefits of innovative building materials?
   ☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good

Section C: Role of Research and Development (R&D)

10. Do you believe R&D plays a vital role in the improvement of building materials?
    ☐ Yes ☐ No
11. To what extent has R&D influenced the use of innovative materials in your projects or region?
    ☐ Not at all ☐ Slightly ☐ Moderately ☐ Considerably ☐ Significantly
12. Are there local institutions or research bodies in Kwara contributing to sustainable building innovations?
    ☐ Yes ☐ No ☐ Not sure
13. Have you ever collaborated with a research institution or participated in any R&D on building materials?
    ☐ Yes ☐ No

Section D: Challenges and Prospects

14. What are the major challenges of using innovative building materials in Kwara State? *(Tick all that apply)*
    ☐ High cost
    ☐ Limited availability
    ☐ Lack of skilled labor
    ☐ Lack of awareness
    ☐ Inadequate policies/support
    ☐ Resistance to change
    ☐ Others (specify): __________________________________
15. In your opinion, what are the main opportunities for increasing the adoption of innovative materials in Kwara? *(Tick all that apply)*
    ☐ Government incentives/policies

- ☐ Training and awareness campaigns
- ☐ Collaboration with research institutions
- ☐ Local production of materials
- ☐ Environmental benefits

16. Would you recommend the use of innovative materials for future sustainable construction in Kwara State?

    ☐ Yes ☐ No ☐ Not Sure

Section E: Open-Ended Questions

17. In your view, how can the use of innovative building materials be improved in Kwara State?

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18. Please suggest any innovative building materials you believe should be adopted more widely in Nigeria.

Declaration:

All information provided in this questionnaire will be used strictly for academic purposes and treated with confidentiality.